

## REVIEW

*The Great Dying*; by Kenneth J. Hsü. P. 292, San Diego, 1986 (Harcourt Brace Jovanovich, \$17.95).—Kenneth Hsü is a masterful writer for one whose native language is not English. He provides a lively account of the events that followed the Alvarez's discovery of the famous iridium anomaly at the terminal Cretaceous boundary. Unfortunately, Hsü does not confine himself to this subject. His book begins and ends with an assault on Charles Darwin. This structure determines the book's astonishing ultimate message: We should abandon the idea that Darwinian natural selection is the dominant source of evolutionary change—or even an important one!

Sandwiched between the salvos against Darwin are eleven chapters that interweave aspects of the general history and philosophy of geology with both anecdotes depicting recent research on the terminal Cretaceous crisis and glimpses of Hsü's personal history since childhood. The book is, in fact, heavily autobiographical. Hsü distances himself not only from Darwinian selection but also from Lyellian actualism. Living scientists and future historians will view with interest Hsü's anecdotes revealing how the Cretaceous bolide hypothesis came into being. His attacks on natural selection will not fare so well.

How could a highly positioned modern-day scientist arrive at a position so heterodox? Regretting that he ever bought into Darwinism, Hsü offers a short chain of propositions to make his case, yet he marshals neither data nor logical inferences to support or connect them. His apostasy originated with the idea that the terminal Cretaceous crisis was not only sudden, it was arbitrary in its choice of victims. Thus, according to Hsü, the event was non-selective. Next comes a leap of faith (p. 276): "Probably all extinction, even the background extinction that goes on all the time, is no less accidental, no more predictable." Finally, there is an unexplained extrapolation: If extinction is non-selective, showing no regard for ecological prowess, then natural selection at the level of the individual must also be dismissed. While jumping to these conclusions, Hsü claims that because mass extinctions result from changes in the physical environment, the biotic interactions upon which Darwin laid great stress play an insignificant role in evolution. In all of these assertions, Hsü ignores a wealth of published evidence.

In fact, it is well documented statistically that both mass extinctions and background extinction are selective, although they often follow different patterns. Certainly, taxa victimized by mass extinctions are often cut down in their prime, and from this we can conclude that in such events the onset of environmental deterioration changed the rules of the game. Patterns of background extinction relate more strongly to everyday limiting factors, which include not only physical conditions but also biotic interactions (for example, food availability, competition, and predation). This is the case because limiting factors, by definition, govern the distribution and abundance of species—and extinction represents the diminution of both these variables to zero. We paleontologists have shown, for example, that certain groups of species subject to heavy

predation or unstable food supply suffer higher rates of background extinction than the rates that characterize other, closely related groups of species. An important point here is that although biological limiting factors may seldom cause the final extinction of a species, they affect probabilities so strongly as to yield differential rates of extinction: when these factors render a species rare, narrowly distributed, or highly unstable in its population size, chance events are likely to eliminate it altogether. Rates of background extinction, speciation, and net increase or decrease in number of species are fundamentally exponential in nature—though usually damped by limiting factors. In a separate article that appeared in *Geology* the year that *The Great Dying* was published, Hsü claimed that one of “Darwin’s three mistakes” was his assumption that species diversity, like number of individuals in a Malthusian population, expands exponentially in the absence of constraints. It is Hsü who is mistaken here, not Darwin. Exponential growth is not linked to sexual reproduction, as Hsü has asserted. Unbridled adaptive radiation is fundamentally exponential, as is the early multiplication of cells reproducing by asexual fission in a Petri dish. In fact, a single species can bud off numerous daughter species simultaneously.

Not only is Hsü mistaken in assuming that extinction generally strikes randomly, he offers no explicit extrapolation to the level of the individual, where Darwin’s arguments had their primary focus. Thus, Hsü discusses extinction extensively but fails to deal adequately with the issue of differential mortality *within* populations. Furthermore, he seems unaware that selection has a second component: differential rates of multiplication. At the level of the species, the process here is speciation. At the level of the individual, the process is reproduction, with fecundity often relating to ecological traits such as ability in food gathering or in defense of helpless offspring against predators. Why should a mass extinction every 20 to 30 my prevent differential birth and death rates, driven in part by ecological factors, from modifying life on Earth during intervening intervals? To what process other than natural selection would Hsü attribute the origins of the magnificently adapted species that populate our world? On this issue he is mute.

Hsü’s prose is entertaining. I only wish that he had applied his considerable writing skills fully to the Cretaceous crisis instead of launching a groundless attack on Darwinian selection.

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